

OCCUPATIONAL CADMIUM SURVEILLANCE OF ADULTS IN NEW JERSEY JANUARY 1986 - SEPTEMBER 1997

JANUARY 1999



**Occupational Disease and Injury Services
Division of Environmental and Occupational Health**

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Occupational Cadmium Surveillance of Adults in New Jersey January 1986-September 1997

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Summary of Cadmium Surveillance

Time Period: January 1986 through September 1997

Data Sources: Clinical laboratories, physicians, hospitals are required to report. Only clinical laboratories have submitted reports to date.

Relevant State Laws/regulations: Reports must be submitted to the New Jersey Department of Health and Senior Services from the following: *Clinical laboratories:* NJAC 8:44-2.11 (reporting requirement: blood cadmium levels equal to or greater than 5 µg/L of whole blood, urine cadmium levels equal to or greater than 10 µg/L before and 3 µg/gram creatinine after 1994); *physicians:* NJAC 8:57-3.2 (reporting requirement: cadmium toxicity, defined as blood cadmium levels equal or greater than 5 µg/L of whole blood, urine cadmium levels equal to or greater than 3 µg/gram creatinine); *hospitals:* 8:57-3.1 (reporting requirement: patient discharge with diagnosis coded ICD 985.5)

Case Follow-up: Reported individuals are mailed 1) a self-administered questionnaire to determine employment status, employer, job title, and source of cadmium exposure, and 2) a pamphlet, *Your Cadmium Level*, which covers sources of exposure, controls, and health effects. Physicians are mailed 1) a letter and 2) a package of educational materials.

Intervention: Employers are mailed a *Cadmium Survey* and *Summary of the OSHA Cadmium Standard*. Upon return of the *Cadmium Survey*, a telephone interview of the employer is conducted by an industrial hygienist using a standard interview form covering industrial hygiene controls. A follow-up letter is sent to the employer giving industrial hygiene recommendations. On-site evaluations by DHSS and/or referral to OSHA are conducted, if necessary.

Summary Data from Disease Surveillance: From January 1986 through September 1997, the DHSS received 402 reports of elevated cadmium levels in 320 individuals. Of these individuals, 164 were exposed occupationally, 33 non-occupationally, and for 123 persons the source of exposure was unknown. The occupational reports include 29 urine levels with a mean of 24.3 µg/L, 21 urine levels with a mean of 6.6 µg/gram creatinine, and 189 blood levels with a mean of 7.6 µg/L. Men accounted for 85% of the occupational cases. The mean age of occupationally exposed individuals was 40. There were large fluctuations in the number of occupational reports received each year; no more than 45 reports were received in any year except 1990 in which 173 were received. Nineteen workplaces using cadmium were identified through reporting.

Hazard Surveillance Protocol: *Cadmium Surveys* were mailed to workplaces using cadmium identified from a variety of databases. Positive responses were prioritized based on the amount of cadmium usage.

Hazard Surveillance Findings: Of the 273 employers who returned the *Cadmium Survey*, 91 (33%) stated that they use cadmium. The New Jersey Community Right to Know (NJCRTK) database identified the largest number of workplaces while the Hazardous Waste Manifest and Cadmium Platers Directory databases had the largest percent positive yield.

Interventions: Fifty-one companies were selected for follow-up, combining data from disease and hazard surveillance. These companies were in nine types of business, including 13 in chemicals and 13 in rubber and plastics. Industrial hygiene evaluations were conducted by telephone followed by a letter with recommendations on how the employer could achieve better compliance with the OSHA cadmium standard. Four on-site workplace evaluations were conducted by DHSS industrial hygienists. Three workplace referrals to OSHA were made; one of these was of a workplace also evaluated onsite by DHSS.

Discussion: Disease and hazard surveillance strategies each contributed to the overall effectiveness of this experimental surveillance effort and each had its limitations. Many employers discontinued using cadmium during follow-up. A legal exemption from the OSHA cadmium standard for dry color formulators and triggering of biological monitoring only by elevated air monitoring means that some employers are not required to perform biological monitoring.

Recommendations:

- 1. A centralized U.S. system of laboratory reporting and disease surveillance for cadmium is feasible and is recommended for consideration as a cost-effective alternative to state-by-state surveillance. If individual states choose to conduct cadmium disease surveillance, they should be prepared for a system that will have a much smaller yield than lead surveillance.*
- 2. Hazard surveillance for cadmium is useful for identifying many more employers using cadmium than are identified by disease surveillance and is recommended for consideration as a possible tool to enhance disease surveillance whether it is being performed state-by-state or nationally.*

Introduction

The adverse health effects of inhaling or ingesting cadmium as listed in **Table 1**¹ are monitored by the New Jersey Department of Health and Senior Services (DHSS) by means of reports of individuals with elevated levels of cadmium in their bodies and identification of workplaces which use cadmium. Workplaces are identified from reports of workers with elevated cadmium (disease surveillance) and also from data on industrial cadmium use (hazard surveillance). Some of the uses of cadmium are shown in **Table 2**.

Table 1: Cadmium Health Effects

- **Acute**
 - pulmonary edema
 - interstitial pneumonitis
- **Chronic**
 - kidney disease
 - emphysema
 - bone lesions
 - prostate & lung cancer

Table 2: Cadmium Uses

- Refining
- Pigment manufacture & use
- Electroplating
- Battery manufacture & recycling
- Construction & demolition
- Cable recycling
- Stabilizer, catalyst, phosphor manufacture & use
- Hazardous waste
- Silver soldering

New Jersey is one of six states with regulations requiring reporting of cadmium toxicity. Reporting levels and sources in the six states are given in **Appendix 1**. In New Jersey, reporting by clinical laboratories went into effect in 1985, requiring reporting of blood cadmium five µg/L of whole blood or greater, or urine cadmium levels of 10 µg/L. In 1993, the reporting regulation was amended to require reporting of urine levels in µg per gram creatinine, with reporting of 3 µg/gram creatinine and greater. Although hospitals have been required to report cadmium poisoning (ICD 985.5) since 1985 and physicians to report same levels as laboratories since 1993, no reports have been received from either group.

Urinary cadmium reflects total body burden, unless renal dysfunction results, in which case it reflects recent exposure. The average daily excretion of cadmium in persons with no known cadmium exposure is usually below 1 µg/L or 1 µg/g creatinine, increasing with age and smoking. Blood cadmium levels reflect recent exposure, with ranges from 0.5 to 3 µg/L in the non-exposed; they are generally not useful for evaluating chronic exposure.

In 1992, the National Institute for Occupational Safety and Health (NIOSH) funded New Jersey to undertake experimental cadmium surveillance under its Sentinel Event Notification System for Occupational Risks (SENSOR) program. The goals of this experimental surveillance are listed in *Table 3*.

Cadmium, rather than other reportable heavy metals like mercury or arsenic, was chosen in 1992 for experimental surveillance because the Occupational Safety and Health Administration (OSHA) had just set a new complete health standard for cadmium², in part because of new information showing that it might be a carcinogen. Many sections of the standard went into effect in December 1992. Among other provisions, the standard lowered the workplace airborne exposure limit for cadmium by a factor of forty, from 200 to 5 µg/m³. Under the standard, employers are required to conduct medical surveillance and biological monitoring of presently and historically cadmium-exposed workers. Required tests include biological monitoring of blood cadmium, urine cadmium, and urinary beta-2-microglobulin, an indicator of kidney damage not specific to cadmium.

Table 3: Goals of Cadmium Surveillance

- Assess the magnitude of occupational cadmium toxicity
- Identify and reduce exposures
- Educate reported individuals and physicians
- Provide technical assistance to employers
- Evaluate usefulness of approach

An increase in the number of cadmium reports being received by the DHSS and other states was expected at the time the grant was funded because of these new biological monitoring requirements. Test results would provide information leading to opportunities for interventions with reported individuals, their physicians, and their employers to reduce cadmium exposures.

Because the DHSS recognized that employers would need assistance in understanding and complying with this complex new standard, part of the SENSOR protocol included outreach to and education of cadmium-using worksites identified by sources other than disease reports. Such outreach was postulated to contribute to an anticipated increase in laboratory cadmium reports as employers came into compliance with the biological monitoring requirements of the standard.

This report summarizes the results of the SENSOR experimental cadmium surveillance project. It includes data on individuals with elevated urine and/or blood cadmium levels who were reported from 1986 through September 1997. It also includes the results of efforts under the SENSOR project to identify worksites where cadmium was in use but which were not identified from disease surveillance. Limitations of the surveillance system and recommendations are presented.

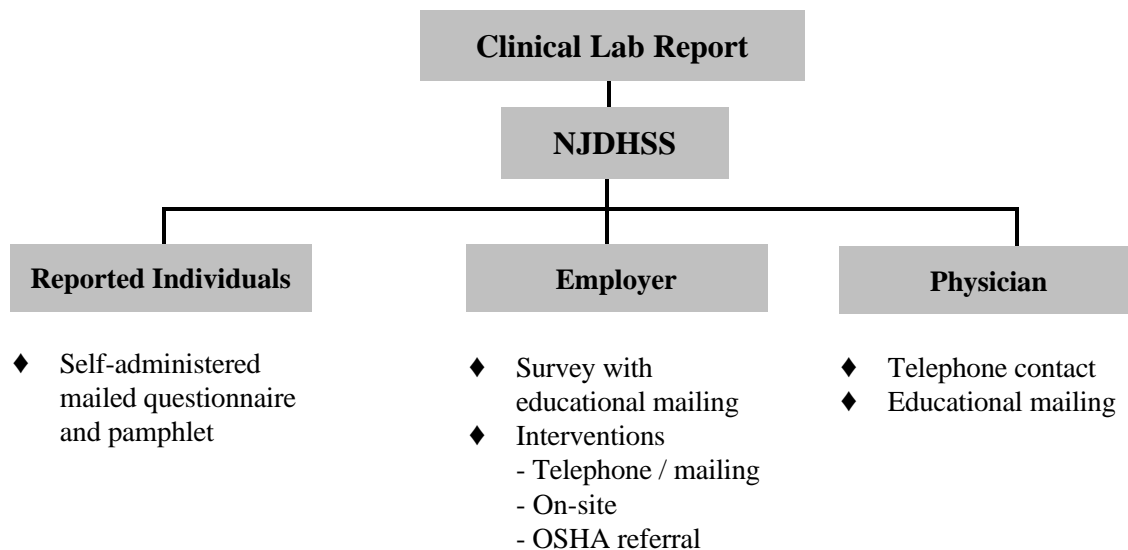
Cadmium Disease Surveillance

Description of Cadmium Disease Surveillance System

A protocol for cadmium disease surveillance is given in *Figure 1*.

Figure 1

Protocol for Cadmium Disease Surveillance



Laboratories report the blood or urine sample results, patient demographic data, and employer information on a standard DHSS form or their own computer-generated form. SENSOR staff review incoming reports and contact the laboratory or medical provider who ordered the test to obtain missing information. Although reporting started in 1986, active follow-up for missing information was not initiated until 1992, with the commencement of the SENSOR project. Source of cadmium exposure is coded “occupational,” “non-occupational” or “unknown.” Information is coded and entered into a dBASE data management system. Employers are assigned a Standard Industrial Classification (SIC) code by a SENSOR industrial hygienist. Data are maintained in password-protected computer accounts and paper files are in locked cabinets.

Patient, physician, and employer contact are initiated for those cases determined or suspected of having occupational exposure to cadmium. Reported individuals receive the following by mail:

- A self-administered questionnaire to determine employment status, employer, job title, and source of cadmium exposure, and
- An educational pamphlet, *Your Cadmium Level*, which covers the sources of exposure, controls, and health effects in lay language.

The physician who ordered the cadmium test receives a package of educational materials including a pamphlet, *What Physicians Need to Know About Occupational Cadmium Exposure*. This pamphlet covers sources of exposure, health effects, treatment, biological monitoring levels of concern, employer and physician responsibilities under the OSHA cadmium standard, and contacts for obtaining more information.

Identified employers are mailed the following items:

- A *Cadmium Survey*, (*Appendix 2*) and
- A *Summary of the OSHA Cadmium Standard*.

In the *Cadmium Survey*, employers are asked about their type of business and how they use cadmium, the amount and frequency of cadmium use, the number of employees potentially exposed, the number of years cadmium has been used, whether biological monitoring for cadmium has been performed in the past year, whether industrial hygiene air sampling had been performed since September 1991, and whether employees are represented by a labor union. If air sampling had been performed, summary data are requested. Results of the surveys are coded and data entered.

Companies that return surveys which indicate current cadmium use are targeted for interventions, including a telephone assessment and mailed follow-up with recommendations, on-site industrial hygiene evaluation, and/or referral to OSHA. Interventions are described beginning on page 13.

Results of Cadmium Disease Surveillance

Number of Reports and Individuals

From January 1986 through September 1997, the DHSS received 402 reports of elevated cadmium levels in 320 individuals as shown in *Table 4*. One hundred sixty-four (51%) of reported individuals, were exposed occupationally, 33 non-occupationally, and for 123 persons the source of exposure was unknown. One hundred twelve (91%) of the 123 individuals with unknown exposure were reported prior to the initiation of active follow-up in 1992.

Table 4
Cadmium Reports by Source of Exposure
January 1986 through September 1997

Exposure Source	Number (%) Reports	Number (%) Unique Individuals
Occupational	239 (60%)	164 (51%)
Non-Occupational	37 (9%)	33 (10%)
Unknown	126 (31%)	123 (39%)
Total	402 (100%)	320 (100%)

Trends in Numbers of Reports

As shown in **Table 5**, there were less than 45 reports received each year except for 1990 in which 173 reports were received. Eighty-two (80%) of the 103 occupational reports in 1990 were from one company.

Table 5
Cadmium Reports by Year

	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	'96	'97*
Occupational	4	8	35	17	103	16	1	16	17	8	5	9
Non-Occupational	0	0	0	0	0	0	0	0	5	19	10	3
Unknown	4	1	7	26	70	4	2	1	1	7	1	2
Total	8	9	42	43	173	20	3	17	23	34	16	14

* through September 1997

Biological Monitoring: Levels of Cadmium in Blood and Urine for Occupationally Exposed Individuals

Seventy-nine percent of the occupational reports were for blood cadmium. Fifty reports were received with urine cadmium levels; 60% were in µg/L and 40% in µg/gram creatinine. **Table 6** displays ranges and means of cadmium levels reports in each of the three test categories.

Table 6
Number, Range, Mean of Occupational Reports

	<i>Number (%)</i> <i>(N=239)</i>	<i>Range</i>	<i>Mean</i>
Blood (µg/L)	189 (79%)	5.0 - 29.0	7.6
Urine (µg/L)	29 (12%)	10.6 - 102.1	24.3
Urine (µg/gram creatinine)	21 (9%)	3 - 19.5	6.6

Demographics of Occupationally Exposed Individuals

Men accounted for 85% percent of the 164 occupationally exposed cases as shown in **Table 7**.

Age at time of first report was available for 141 (86%) of the 164 occupationally exposed individuals. Their ages ranged from 19 to 69, with a mean age of 40.

Race was obtained on too few cases [N = 22 (13%)] to be meaningful.

Table 7
Gender and Age of Occupationally Exposed Individuals

Gender	Number	(%)
Male	140	(85%)
Female	24	(15%)
Age at time of first report		
Age Group	Number	(%)
< 30	28	(20%)
30-39	47	(33%)
40-49	39	(28%)
50-59	21	(15%)
60-69	6	(5%)
Total	141	(100%)

Industries of reported individuals

The 164 individuals worked for 19 employers. Three employers with the largest number of reported workers had 15, 39 and 75 workers reported respectively. The remaining employers were identified by from one to eight reported employees each, including seven with only one employee each. Two employers, with two and four reports respectively, were first identified by hazard surveillance, and the disease reports were received subsequent to the hazard surveillance survey mailing.

Table 8 groups the employers by industry, including the number of reported individuals and number of worksites for each grouping. This table also identifies the specific source of cadmium exposure within each industry, when known.

Table 8
Industry Groups (Exposure Sources), Number of Reported Individuals, and
Number of Worksites Identified from Laboratory Reporting

Industry (specific cadmium exposure source, if established)	Number Individuals	Number Worksites
Manufacturing		
Inorganic pigments (blending pigments)	81	5
Inorganic chemicals (unknown cadmium use: discontinued in 1990)	2	1
Decorative glassware (paints)	2	1
Smelting, refining: non ferrous metals (refining metal)	15	1
Rolling/extruding: non-ferrous metals (manufacturing solder)	41	2
Current-carrying wiring (unintentional flaking of cadmium plating)	8	1
Communications equipment (satellite manufacturing)	2	1
Retail Trade		
Scrap and waste materials (burn, cut scrap metal)	6	1
Services		
Commercial art (paint)	1	1
Hospital (casting of radiation shielding devices)	2	1
Environmental clean-up services (unknown)	3	3
Unknown Type of Industry [company could not be located]	1	1
Total	164	19

Results of Employer Survey: Identification of Companies for Intervention

Twelve of the 19 employers were targeted for interventions because the employer survey determined that they were in business and using cadmium. The result of the follow-up with these 12 companies are discussed on pages 15-17.

The remaining seven employers were not targeted for interventions for the following reasons:

- One employer could not be located and was presumed to be out of business.
- The artist, who was self-employed, had received information about cadmium in our patient mailing.
- One employer had discontinued using cadmium.
- The three environmental clean-up companies claimed they were unaware of any cadmium exposure. The environmental workers' cadmium levels had been detected as part of routine screening for heavy metals, a common practice for hazardous waste workers.

- The two individuals reported by the hospital had been medically screened for cadmium exposure as a result of an educational mailing by DHSS to hospitals about lead and cadmium hazards to workers making radiation shielding devices. This educational mailing was developed after follow-up by the DHSS lead surveillance system found lead, and, incidently, cadmium, being melted in these operations. No further interventions were deemed necessary. See case study (1) on page 21.

Laboratories occasionally reported individuals whose blood or urine levels were below the legally mandated reporting level. Four additional potential cadmium using employers were identified from such reports. Follow-up determined that cadmium had been discontinued at two worksites and that there was very negligible cadmium exposure at the other two sites.

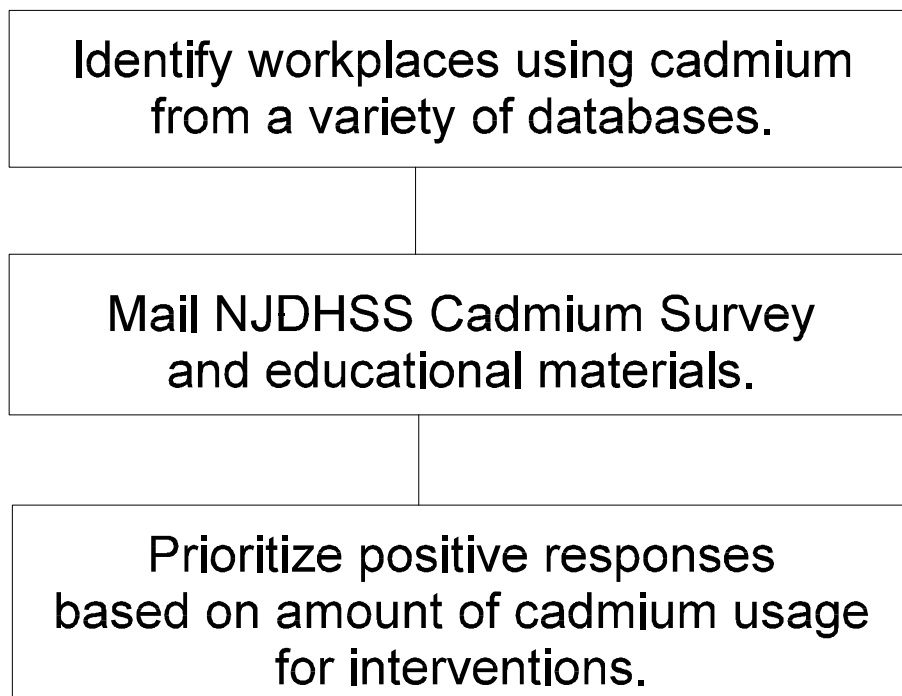
Cadmium Hazard Surveillance

Description of the Cadmium Hazard Surveillance System

The protocol for cadmium hazard surveillance is given in *Figure 2*.

Figure 2

Protocol for Cadmium Hazard Surveillance



Identification of employers for hazard surveillance

Employers who were potential users of cadmium were identified and selected from the data sources enumerated in **Table 9**. The first three databases listed in **Table 9** involve self-reporting of cadmium inventories by employers. The first database is unique to New Jersey; the others are available for all states. More detailed information on these databases is given in **Appendix 3**.

Table 9
Databases and Selection Criteria Used for
Finding Workplaces Using Cadmium

Database	Selection Criteria
(1) NJ Community Right-to-Know (NJRTK) Survey	Reporting of cadmium inventories (eight CAS numbers for cadmium and cadmium compounds)
(2) Toxic Release Inventory (TRI)	Reporting greater than 10,000 lb. of cadmium
(3) DEP Hazardous Waste Manifests	Manifesting of waste containing cadmium or cadmium and compounds
(4) Thomas Register online	Vendors of products beginning with the word "cadmium" or other relevant headings such as "colors-dry"
(5) Cadmium Platers Directory	Platers listed in New Jersey
(6) NJ employers in SIC Codes 2816 and 2865 paying unemployment insurance	SIC Codes: 2816 Inorganic Pigments 2865 Organic Dyes and Pigments

The list of companies from each source were combined into one database that identified all data sources for each company. This list was matched with the list of employers identified by disease surveillance to determine overlap.

Survey of employers to determine cadmium use

The ***Cadmium Survey***, which was the same employer survey that was used to collect information from companies identified by laboratory reports (see page 6), was sent to employers identified by hazard surveillance in order to verify current cadmium use and potential for exposure. The ***Survey*** and ***Summary of the OSHA Cadmium Standard*** were sent in four mailings between February 1993 and November 1996 to identified employers. Telephone calls and repeat mailings were made to encourage response to the survey.

Information on cadmium use (duration, frequency, amount used per year, and type of industrial process) was viewed as a surrogate for exposure and used to target sites for intervention follow-up. Sites targeted were those using more than 100 pounds of cadmium per year and where cadmium exposure was possible, or sites using less than 100 pounds but where significant cadmium exposure was likely.

Results of Hazard Surveillance

Three hundred fifty-six employers identified by one or more of the databases, excluding five that had already been identified by disease surveillance, were mailed the cadmium survey. Twenty (6%) of the 356 employers were identified by more than one database. Of the 273 (77%) employers who returned the ***Cadmium Survey***, 91 (33%) stated that they used cadmium. ***Table 10*** summarizes the usefulness of each database in finding workplaces using cadmium.

Table 10
**Usefulness of Databases for
 Finding Workplaces Using Cadmium**

Database Used to Find Workplaces Using Cadmium	Number of employers identified for mailing survey	Number (%) of employers returning survey	Number of employers returning survey stating that they use cadmium	Percent Positive yield from respondents
NJ Community Right-to-Know (NJRTK) Survey	226	182 (81%)	68	37%
Toxic Release Inventory (TRI)	9	4 (44%)	2	50%
DEP Hazardous Waste Manifests	44	32 (72%)	17	53%
Thomas Register online	36	24 (50%)	4	16%
Cadmium Platers Directory	18	9 (50%)	5	55%
NJ Employers in SIC Codes 2816 and 2865 paying unemployment insurance	47	43 (91%)	5	12%
All*	356	273 (77%)	91	33%

*Numbers in this row are less than totals for columns because some companies were identified by more than one source

The NJRTK database identified the largest number of workplaces while the Hazardous Waste Manifest and Cadmium Platers Directory databases had the largest percent positive yield. Using only the Right to Know and the Hazardous Waste databases, seventy nine (89%)** of the 91 cadmium users would have been captured.

Forty-one of the 91 cadmium-using companies met the selection criteria for intervention.

** Note that this number is less than the total for both databases in ***Table 10*** because some companies were identified by both sources.

Interventions

Description of Companies Meeting Criteria for Intervention Follow-up

Fifty-one companies were selected for follow-up, combining data from disease and hazard surveillance. These included five companies identified by disease surveillance only, 39 identified by hazard surveillance alone, and seven identified by both, including two that were first contacted as a result of hazard surveillance and subsequently identified by elevated cadmium biological monitoring results, as shown in *Table 11*.

Table 11
Companies Selected for Intervention
by Method for Company Identification

Company Identification Method	Number (%)
Disease surveillance only	5 (10%)
Disease followed by hazard surveillance	5 (10%)
Hazard followed by disease surveillance	2 (4%)
Hazard Surveillance only	39 (76%)
Total	51 (100%)

Table 12 categorizes the 51 companies by type of business. The total number of employees at the companies and the number of cadmium-exposed employees as self-reported by the employers are also presented in **Table 12**.

Table 12
Type of Business and Number of Employees Exposed to Cadmium at
Workplaces Selected for Intervention

2-Digit SIC Code	Type of Business	Number of Facilities	Number of Employees	Number Cadmium Exposed Employees
22	Textile mill product	1	53	15
28	Chemicals	13	580	124
30 & 32	Rubber, plastics	13	2,530	247
33	Primary metal	7	891	81
34	Fabricated metal	7	606	21
36	Electronics	3	3,430	523
39	Artist's material	1	85	42
49	Electric, gas, sewer service	3	107	83
50 & 51	Wholesale trade	3	375	45
Total		51	8,609	1,181

Methods for Interventions

DHSS industrial hygienists conducted telephone industrial hygiene evaluations of identified workplaces using a standard interview form entitled *Evaluation of New Jersey Workplace Which Uses Cadmium*. (Appendix 4) The evaluation established continued use of cadmium and gathered information concerning the employer's industrial hygiene control programs. If the employer had conducted biological monitoring of employee, the results by job title (but without employee names) were requested and reviewed. If the employer had conducted air sampling, detailed results were requested and reviewed for adequacy.

Following the telephone industrial hygiene evaluation, a letter was sent to the employer giving recommendations on industrial hygiene improvements that might bring the employer into better compliance with the OSHA cadmium standard.

The following areas were addressed in industrial hygiene recommendations from the NJDHSS:

- exposure limits
- exposure monitoring
- regulated areas
- engineering controls
- respiratory protection
- protective clothing
- hygiene facilities
- lunchroom
- housekeeping
- employee information and training
- written compliance plan
- emergency plan
- medical examinations
- medical removal

A response from the employer was requested within 60 days. Responses were reviewed when received and telephone or further written communication was made as needed. Often air sampling data were requested to assist in on-going consultation.

Workplaces were visited for on-site evaluations if they appeared to have exposure problems. Workplaces were referred to OSHA for inspection under the cadmium standard if the employer did not cooperate with the DHSS telephone evaluation or failed to demonstrate efforts to comply with our major recommendations.

At the completion of the interventions for each company, the data file was updated with information on current cadmium exposure categorized as: 1) exposure greater than the OSHA Permissible Exposure Limit (PEL), 2) exposure greater than the OSHA Action Level (AL), 3) exposure adequately controlled, 4) no current exposure - cadmium use discontinued, or company closed. For updating purposes, the highest reported full-shift exposure was coded.

Results of Interventions

One or more of the interventions were completed for 41 of the 51 targeted companies. Telephone follow-up with nine of the 10 remaining companies determined that cadmium use had ceased since response to the initial survey. With the tenth company, we were unable to obtain sufficient information to determine the use of cadmium or appropriateness of intervention.

The forty-one targeted companies were interviewed by telephone. Those who had not already done so were advised to collect and/or asked to provide air sampling data. Other recommendations were provided as appropriate in the letter that followed the telephone evaluation.

Twelve of the 41 companies provided air sampling results that showed cadmium in air greater than the OSHA AL, including seven with results greater than the PEL. Four of the 12 companies were evaluated by DHSS industrial hygienists, two were referred to OSHA for compliance inspections, and one received both interventions. These DHSS and OSHA activities are presented in the section on case studies on pages 20-22. One site evaluated by DHSS and one by OSHA ceased using cadmium subsequent to these interventions.

The remaining five companies with cadmium air levels above the AL provided sufficient information on the controls for cadmium to enable the DHSS industrial hygienist to judge that on-site interventions or OSHA referrals were not likely to affect exposure, including four that were in compliance with most of the provisions of the cadmium standard and one that was exempt because of a legal stay that was successfully obtained by the Color Pigments Manufacturer's Association, Inc. (CPMA)³.

Cadmium exposure had been a one-time, unintentional occurrence due to flaking cadmium plating from a part being used in assembly at one of the 41 companies which had been identified by disease surveillance. We provided extensive telephone consultation to ensure that adequate clean-up and evaluation had occurred. See case study 5. on page 21.

Twenty-two companies with evidence that cadmium air levels were below the OSHA AL or that would most likely have been less than the AL because of how cadmium was used, and two with very low results from biological monitoring were closed without on-site or OSHA intervention because they were judged to have very low or no exposure potential.

Finally, four companies, which did not provide air data, ceased using cadmium following our telephone interview and letter with recommendations.

A summary of the types of interventions is provided in *Table 13*.

Table 13
Interventions with Employers Following Telephone Evaluations
by Cadmium Air Level Reported by the Employer

Interventions	Cadmium Air Levels			
	>AL	<AL	Not provided	Total
DHSS on-site	4*			4
OSHA referral	2*			2
OSHA & DHSS	1*			1
Telephone consultation only			1*	1
None: likely in compliance	5	22	2	29
None: exposure ceased			4	4
Total	12	22	7	41

*Described in case studies on pages 22-23.

Discussion

Cadmium is a serious but limited industrial hazard. In the eleven years that reporting of elevated blood and urine cadmium levels has been mandatory in New Jersey, only 239 reports of 164 individuals with occupational exposure were received. Numbers of reports from occupationally exposed individuals ranged from 1 to 35 per year with one exception.

New Jersey has received more elevated blood and urine cadmium reports than any other state requiring reporting, as shown in *Appendix 5*, although the number of reports appears to be quite small given the many uses of cadmium.

Compared to lead, relatively few U.S. clinical laboratories perform cadmium analyses of blood and urine. The most recent listing of proficient laboratories, which is available from the Quebec Toxicology Center (QTC), is summarized in *Appendix 6*. Currently 11 laboratories are proficient for cadmium in blood and 12 for urine. The QTC program is the only fully operational interlaboratory proficiency program for cadmium on the North American continent. The College of American Physicians (CAP) is field-testing a similar program at this time. Given the small number of proficient laboratories, a national reporting system may be a more efficient surveillance tool than many, small, state-based ones.

Although an increase in laboratory reports of cadmium in blood and urine was expected after 1992 because of the new OSHA cadmium standard requiring biological monitoring, this increase was not seen; in fact, there were fewer reports annually in the mid 1990's than in the late 1980's. Results of extensive follow-up with employers identified from these reports and from databases of industrial cadmium use suggest some explanations for these observations.

First, many companies that used cadmium at one time appeared to be ceasing the use of cadmium at the time of our follow-up. Only 91(33%) of the 273 respondents to the hazard surveillance survey claimed they still used cadmium at the time of the survey. Follow-up with 51 companies believed to be significant users of cadmium, combining companies from hazard surveillance and disease surveillance, found that thirteen of the 51 targeted employers discontinued cadmium use.

Second, was the impact of the exemption from all provisions of the cadmium standard that was obtained by the Color Pigment Manufacturers Association, Inc. for dry color formulators.* Twelve of the 51 significant cadmium using employers were covered by the exemption and therefore were not required to do biological monitoring. It should be noted however, that six of the 12 employers had conducted biological monitoring regardless of the exemption, and employees at two of these six companies had elevated cadmium levels that were reported by laboratories. See case studies 4. and 7. on page 21.

* On March 22, 1994 the Eleventh Circuit Court of Appeals ruled that OSHA had not proven that compliance with the cadmium standard was economically and technologically feasible for the dry color formulating industry.

Finally, half of the targeted companies that had ongoing cadmium use provided some evidence that air cadmium levels were less than the OSHA Action Level or would most likely have been less than the AL because of the way cadmium was used in the facility. These companies are not required to conduct biological monitoring by OSHA.

The validity of these explanations presumes that the combined hazard and disease surveillance strategies effectively identified the universe of cadmium using employers in New Jersey, but this may not have been the case. Overall, there was a 23% non-response rate to the hazard surveillance survey, and it is possible that some of the companies that did not respond to the survey were cadmium users. However, many of these employers did not appear likely to be users based on their SIC codes. It is also possible that the surveys did not accurately capture employer cadmium use. Resources did not permit independent verification of survey results.

If the combined strategy of disease surveillance and hazard surveillance brought most, if not all, significant employers into the net of the surveillance system, then it is reasonable to conclude that unless there are major new industrial changes in New Jersey, the number of laboratory reports of elevated blood and urine cadmium is not likely to increase in the future. For laboratory reporting to potentially increase, within the current industrial use situation, there would need to be changes in the OSHA cadmium standard to remove the exemptions which allow employers not to perform biological monitoring of employees exposed to cadmium, or OSHA would need to require initial biological monitoring of all workers exposed to cadmium without regard to measurements of airborne exposure or the number of days a year cadmium is in use.

This surveillance system led to seven major on-site evaluations, three that were conducted by DHSS industrial hygienists, two by OSHA, and one first by DHSS and then by OSHA when the employer was not making efforts to following our recommendations. Cadmium exposure at all of these sites was above the AL. Two of these sites were first identified by hazard surveillance, the other five were from disease surveillance. Although the “yield” from the surveillance system in terms of intervention-suitable companies was relatively small, the exposure problems at all of these sites were significant and most will require ongoing evaluation to ensure that workers are being protected appropriately.

Disease and hazard surveillance strategies each contributed to the overall effectiveness of this experimental surveillance effort and each had its limitations.

Disease surveillance identified few companies, but alone would have identified five out of the seven worksites targeted for on-site intervention. However, after 1992, only two new companies came into the disease surveillance system, and laboratory reporting continued to be sporadic. By the end of the project, it did not appear that disease surveillance was yielding very much new information useful for public health activities.

Disease surveillance has always been impeded by incomplete laboratory reporting of employee address and demographic data and/or employment information. For example, for thirty-one percent of all cadmium reports, the source of cadmium exposure was not identified. In an attempt to remedy this problem, in 1993 the DHSS mandated reporting of these data elements by laboratories and then initiated meetings with the major testing laboratories. It appears that resolution of this problem will not take place easily because clinical laboratories do not require physicians who order cadmium tests

to provide the laboratory with such information. Follow-up to obtain missing information is very labor intensive

Hazard surveillance provided important information to understand the impact of the OSHA cadmium standard in New Jersey worksites, and it also identified many of the employers identified by disease surveillance. Nevertheless, the combined hazard surveillance databases did not capture 5 of the 19 employers identified by disease surveillance. The design of the intervention to include mailed follow-up assessments to provide education and screen for on-site evaluation was an effective use of industrial hygiene expertise. This intervention strategy involved relatively few staff resources compared to onsite evaluations.

Based on these findings, all laboratory reports will continue to be reviewed to determine if biological levels are unusually high or new workplaces are identified. Employers that have provided information indicating on-going cadmium exposure will be followed over time to ensure that they are in compliance with OSHA's requirements. The DHSS will not continue with intensive efforts to obtain case information missing from the laboratory report or continue with hazard surveillance unless there are significant changes to the OSHA cadmium standard.

The DHSS recommends the following to other states and to NIOSH:

Recommendation 1

A centralized U.S. system of laboratory reporting and disease surveillance for cadmium is feasible and is recommended for consideration as a cost-effective alternative to state-by-state surveillance. If individual states choose to conduct cadmium disease surveillance, they should be prepared for a system that will have a much smaller yield than lead surveillance.

There are only twelve U.S. clinical laboratories currently proficient for performing cadmium testing. This presents an opportunity for a centralized U.S. system of laboratory reporting and disease surveillance for cadmium. There is one precedent for centralized surveillance of an occupational disease. This is the **U.S. Beryllium Case Registry** which operated out of Massachusetts General Hospital and later out of NIOSH during the 1950s to 1980s ⁴. The Registry's services included gathering of information, evaluation of new cases of beryllium disease, long-term follow-up of reported patients, and referral services for the medical profession.

Recommendation 2

Hazard surveillance for cadmium is useful for identifying many more employers using cadmium than are identified by disease surveillance and is recommended for consideration as a possible tool to enhance disease surveillance whether it is being performed state-by-state or centrally.

The use of a product or SIC based approach to hazard surveillance (Thomas Register and state data on employers paying unemployment insurance) is less productive than using databases that are directly associated with cadmium use. Therefore, the DHSS recommends using the TRI and Hazardous Waste databases, and the Cadmium Platers Directory. A combination of mailed surveys and follow-up telephone calls can identify major cadmium users quickly and efficiently. Unfortunately no other state has industrial use data that is as comprehensive as the NJ RTK data.

Case Studies

1. Exposure to cadmium in a common non-industrial operation: A medical center with two registered radiation treatment machines produced custom shielding blocks for individuals undergoing treatment. They were one of 80 similar facilities to be mailed a DHSS informational bulletin entitled *Guidelines for Controlling Lead and Cadmium Exposures During Shielding Block Fabrication in Radiation Treatment Facilities* after lead disease reporting identified a hazard in this operation. Two reports of elevated urine cadmium levels were received, one on a current shield maker and one on a long-term former shield maker. The employer has reevaluated the use of personal protective equipment in the area and has hired an industrial hygienist to collect air and wipe samples. Blood and beta-2-microglobulin tests will also be performed on the exposed and historically exposed individuals.

2. Referral to OSHA of a non-cooperative pigment manufacturer: One elevated blood report was received on an employee of a pigment manufacturer which had already been identified by hazard surveillance. DHSS tried unsuccessfully to obtain current air and biological monitoring results on all exposed employees. The employer's 1991 sampling data and a previous OSHA inspection showed high exposure levels. Due to non-cooperation by the employer, a referral to OSHA was made in December 1995. As a result of this DHSS referral to OSHA under the Memorandum of Understanding (MOU) on cadmium, citations and \$3,000 in proposed fines were issued to the employer in February 1996. OSHA found failure to monitor employee exposures to cadmium, provide biological monitoring and medical surveillance, provide required information to the examining physician, obtain written medical opinions from the examining physician, provide information and training on cadmium to employees, and allow access to records. The employer told OSHA that they had discontinued cadmium production in October 1995. An individual reported to the DHSS with an elevated cadmium level reported that cadmium was still in use in February 1996, however. OSHA was notified and re-inspected in March 1996 to interview employees and determine the cause of the continuing elevated cadmium level. It was learned that some cadmium milling and/or packaging operations were still being performed once or twice a month. The worker with the elevated level did no milling or packaging but performed maintenance on machinery potentially contaminated with cadmium. OSHA collected wipe samples and conducted air sampling at milling and packaging. Willful citations for violations of obligations triggered by their continued use of cadmium were issued to the employer in July 1996. Subsequently, the employer has stated in writing to the DHSS that they have discontinued all cadmium use.

3. Lack of cadmium controls while making solder and brazing products: An on-site evaluation was conducted in May 1995 of two businesses involved in two different types of solder and brazing product manufacturing under one roof, one for the jewelry industry and the other for the automotive industry. Lead was in use as well as cadmium. Biological monitoring results on employees of both companies showed normal lead and cadmium results except for one reported individual. A report was issued in June 1995 recommending written health and safety programs on respirators, personal protective equipment, and hazard communication. Unsatisfactory findings resulted in recommendations in the areas of respiratory protection, first aid, engineering controls, personal protective equipment, housekeeping, hazard communication, chemical hazards, and noise. Wipe sample results in the lunch and locker rooms were summarized and mailed to the employer in August 1995 showing problems with cadmium and lead contamination on the inside of a refrigerator and lockers. The employer did not respond to DHSS recommendations, phone calls, or correspondence, leading to an OSHA referral in August 1997 after an additional elevated blood cadmium report was received. OSHA cited the employers and proposed penalties of \$209,750 for six alleged willful, eight

alleged serious, and two alleged other-than-serious violations of OSHA standards. OSHA alleged that the company failed to evaluate employee exposure to cadmium, failed to train employees on the hazards of cadmium exposure, and failed to provide employees with appropriated medical surveillance.

4. Custom color formulator exempted from compliance with the cadmium standard: A manufacturer of custom color plastics was visited in January 1993 because of reports of elevated cadmium blood levels received in November 1990. A report was issued that recommended improvements in exposure monitoring, respirator selection and use, HEPA vacuums, engineering controls, and regulated areas. The employer responded by stating that they were covered by the legal stay on the cadmium standard for dry color formulators. They noted that attempts to retrofit non-HEPA vacuums by adding HEPA filters to the exhaust were unsuccessful because the filter resistance caused the motors to burn out. All improvements were put on hold by the employer pending construction of a new facility.

5. Unexpected exposure from flaking cadmium plating: Employees of a manufacturer of electrical wire connectors were exposed to cadmium when plating flaked off of a component spring. The problem was discovered when employees began to get sick. A clean-up company was hired to remediate the contamination. Telephone consultation following seven elevated cadmium reports resulted in several DHSS recommendations, including evaluation of possible cadmium contamination in employees' vehicles and homes, continued medical follow-up of five pregnant employees potentially exposed to cadmium, and release to the DHSS of the identity of the company which supplied the defective spring so that the potential for other exposures could be evaluated. Most recommendations were not followed because the employer considered the cadmium exposures sufficiently controlled.

6. Decorating glass using cadmium: This manufacturer of decorative glassware used cadmium and lead in decorating operations. An on-site visit was conducted after elevated cadmium reports were received. Subsequent re-tests were normal and air sampling results were generally low. The DHSS report was issued in August and the employer responded, agreeing to many of recommendations to lower cadmium and lead exposures.

7. Color house discontinues using cadmium: This manufacturer of custom colors for plastics was covered by the stay on the OSHA cadmium standard. Air sampling taken in May 1994 by a consultant and received by the DHSS in October 1995, found cadmium exposure up to 30 times the PEL. Lead was in use as well as cadmium. Lead exposure was not evaluated because it was not used the day air sampling was performed. The employer performed biological monitoring on eight employees for lead and cadmium in November 1995 in response to DHSS's recommendation. Results showed lead levels were normal. One production worker had an elevated beta-2-microglobulin; another had a cadmium urine level of 3 µg/gram creatinine, the lowest reportable level. A site visit to evaluate engineering controls was conducted March 1996 by a DHSS industrial hygienist. Recommendations for improvements were sent to the company in writing. Subsequently, DHSS was notified in writing that the facility no longer manufactured products containing cadmium. The company was advised of precautions to use during decommissioning of the former cadmium production area.

8. *Cutting cadmium plated scrap metal:* Several reports of elevated cadmium levels were received on two current employees and three individuals given pre-employment physicals by this scrap processor. Employees were potentially exposed to cadmium and lead during metal cutting with acetylene torches. The employer was advised by letter to perform representative air monitoring and use a proficient laboratory for analysis. A referral was made in April 1995 to OSHA concerning both lead and cadmium exposure. OSHA found that cadmium air levels were above the action level but below the permissible exposure level and that the employer had implemented adequate lead and cadmium compliance programs.

9. *Precious metal processing:* Reports of elevated cadmium levels in seven individuals at this refiner of precious metals were received by the DHSS between 1989 and 1993. An onsite evaluation was performed in 1993 to evaluate exposure to cadmium and platinum salts. The report recommended improvements in exposure monitoring, regulated areas, housekeeping, chemical protective clothing, hygiene facilities and lunchroom, and medical surveillance. The employer responded positively to 15 of the recommendations, disagreed with one, and made no response to the remaining 13. In the course of DHSS's interactions with this employer, several official interpretations of the OSHA cadmium standard needed to be obtained in order to deal with unusual interpretations made by the employer. The employer has a sophisticated industrial hygiene program, is aware of problems areas, and continues to reassess these areas. Updated information on air and biological levels was recently requested and received from the employer since no elevated reports had been received in several years. Twenty individuals are currently in the cadmium biological monitoring program; two had elevated blood levels and one had an elevated urine level in 1997. Air levels continue to exceed the OSHA PEL and SECAL although some engineering improvements have been made.

References

1. *Case Studies in Occupational Medicine, Cadmium Toxicity*, US Dept. of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, June 1990.
2. *Occupational Exposure to Cadmium, Final Rules*, 29 CFR 1910, et. al., US Dept. of Labor, Occupational Safety and Health Administration, Federal Register, September 14, 1992.
3. *Enforcement Guidance Pertaining to Stay of the Cadmium Standard with Respect to Cadmium Pigments*, J.B. Miles, USDOL-OSHA, Wash., DC, September , 1994.
4. Tanaka, S., et. al., *Beryllium Disease. Necessity for Continuing Surveillance*, Chest, Vol. 84, 312 (1983).

Appendix 1

Cadmium Surveillance States Reporting Levels and Sources

<i>State</i>	<i>Year Started</i>	<i>Blood reporting level, ug/L</i>	<i>Urine reporting level, ug/L</i>	<i>Reporting sources</i>
<i>CO</i>	<i>1988-1977</i>	<i>> 10</i>	<i>> 10</i>	<i>laboratories</i>
<i>IO</i>	<i>1989</i>	<i>> 5</i>	<i>> 10</i>	<i>laboratories, physicians</i>
<i>MD</i>	<i>1988</i>	<i>≥ 10</i>	<i>≥ 20</i>	<i>laboratories</i>
<i>MA</i>	<i>1992</i>	<i>≥ 5</i>	<i>≥ 5¹</i>	<i>physicians</i>
<i>NY</i>	<i>1982</i>	<i>≥ 10</i>	<i>≥ 5</i>	<i>laboratories, physicians, hospitals</i>
<i>NJ</i>	<i>1985</i>	<i>≥ 5</i>	<i>≥ 10</i>	<i>laboratories, hospitals</i>
<i>NJ</i>	<i>1993</i>	<i>≥ 5</i>	<i>≥ 3¹</i>	<i>laboratories, physicians, hospitals</i>

¹ *μg/gram creatinine*

New Jersey State Department of Health
Occupational Health Service
CN 360, Trenton, NJ 08625-0360

Please make any corrections necessary to the label.

Name of Individual Completing Survey	
Title	
Telephone Number	
()	
1. Are materials that contain cadmium or cadmium compounds used or produced at this locations?	1. 1 <input type="checkbox"/> Yes [CADUSE] 2 <input type="checkbox"/> No, Not Used in Past 2 Years 3 <input type="checkbox"/> No, Eliminated Use During Past 2 Years On: _____/____/____ (Date)
If the answer is "No," do not proceed further. However, be sure to return the survey since it is necessary that your response be recorded.	
2. Which best describes your use of cadmium over the past 2 years?	2. a <input type="checkbox"/> Remained Constant [PUSE] b <input type="checkbox"/> Decreased c <input type="checkbox"/> Increased
3. Which best describes your anticipated use of cadmium over the next 2 years?	3. a <input type="checkbox"/> Will Remain Constant [FUSE] b <input type="checkbox"/> Will Decrease c <input type="checkbox"/> Will Increase d <input type="checkbox"/> Will be Eliminated
4. What does your business do or produce? Be brief.	4. _____ [TYPE] _____
5. What is your primary SIC Code?	5. _____ [SIC]
6. Total number of employees at this location.	6. _____ [NUMEMPLOY]
7. Estimate how many employees have potential cadmium exposure.	7. _____ [NUMEMPEXP]
8. How many days a year does cadmium use or production occur?	8. _____ [FREQEXPO]
9. How do you use or produce cadmium or cadmium compounds? Be brief.	9. _____ _____ _____
10. How much cadmium or cadmium-containing material do you use or produce in total pounds per year?	10. _____ lbs/Year [CADAMT]
11. For how many years have you been using cadmium or cadmium compounds at this location?	11. _____ [NUMYRS]
12. Have you performed biological monitoring for cadmium in employees' blood or urine in the past year?	12a. Blood 1 <input type="checkbox"/> Yes [BLOOD] 2 <input type="checkbox"/> No
13. If you answered "Yes" to Question 12a, b or c, give the name, address, and telephone number of the physician or clinic you used.	12b. Urine 1 <input type="checkbox"/> Yes [URINE] 2 <input type="checkbox"/> No
Name _____ Street _____ City, State _____ Zip _____ Telephone _____	12c. Beta-2-Microglobulin in Urine 1 <input type="checkbox"/> Yes [BETA] 2 <input type="checkbox"/> No

Appendix 2

PART 1: CADMIUM SURVEY, Continued

14. Are your employees represented by a labor union? 14. 1 ☐ Yes 2 ☐ No [UNION]

15. If you answered "Yes" to Question 14, give the name, address, and telephone number of the union here.

Name _____

Street _____

City, State _____

Zip _____

Telephone _____

16. Have you performed industrial hygiene air sampling for cadmium since 9/14/91? 16. 1 ☐ Yes 2 ☐ No [AIRMON]

If you answered "Yes" to Question 16, fill out Part 2, summarizing the results. Use additional pages if necessary. Copies of sampling results are acceptable if all the requested information is given.

PART 2: AIR SAMPLING SUMMARY

Date of Sample (MM/DD/YY)	Sample Location, Department, Job Title, Job Activities	Sample Type (Area, Personal)	Sample Duration (Minutes)	Results (Give Units)

Sampling Performed By

Name:

Title:

Telephone No.: ()

Company Name and Address (if performed by an outside consultant)

Thank you for your cooperation!

If you have any questions, please call Eileen Senn or Don Schill at 609-984-1863. Please return to NJSDH in the enclosed postage-paid envelope or to the attention of "Cadmium Survey" at the address above.

NJSDH USE ONLY:

17. _____ [SOURCEREF]

20. _____ [DATERET]

18. _____ [EXPOSURE]

21. _____ [SURVEYSTAT]

19. _____ [DATESENT]

Appendix 3

Description of Hazard Surveillance Databases

NJ Community Right to Know (NJCRTK): New Jersey Department of Environmental Protection (NJDEP) Community Right to Know (NJCRTK) data identifies 33,000 New Jersey workplaces, in all manufacturing plus some non-manufacturing SIC Codes, reporting the use or storage of certain chemicals, including the amount in inventory or use. The database covered 2000+ chemicals with no reporting threshold before 1994. In 1994 the list of chemicals was reduced to 800+ and reporting thresholds were established. As The US Environmental Protection Agency (USEPA) makes new chemicals reportable under TRI, they will become reportable under NJCRTK. All chemicals regulated by full OSHA standards are currently covered. To identify workplaces using cadmium, eight different CAS numbers for cadmium and various compounds were used.

Relevant data includes NJEIN #, Federal EIN#, employer name, street, city, state, zip, SIC Code, chemical name, CAS number, and the maximum daily inventory of each chemical listed in the RTK Environmental Hazardous Substance List.

The advantage of this database is the large number of employers and chemicals covered, its availability on electronic media, and the fact that it is updated annually. Its disadvantages is that it is based on self-reporting and only exists in New Jersey.

Toxic Chemical Release Inventory (TRI): The Superfund Amendments and Reauthorization Act of 1986 (SARA), Title III, Section 313, requires certain manufacturers to report environmental releases and waste transfers for more than 600 toxic chemicals and chemical groups, including all chemicals regulated by full OSHA standards. All manufacturers who have 10 or more full time employees, and manufacture (including import), process, or otherwise use any of the reportable toxic chemicals or chemical groups above thresholds of 25,000 lbs. manufactured and 10,000 lbs. otherwise used, must comply with Section 313. Facilities covered by Section 313 must submit the Toxic Chemical Release Inventory Reporting Form (Form R), which includes information about annual on-site releases to air, water, and land, and off-site transfers to publicly owned treatment works (POTWs), landfills, and other offsite treatment locations. Manufacturers send the completed original forms to the U.S. Environmental Protection Agency (USEPA) and a copy to the New Jersey Department of Environmental Protection (DEP). Form R is due July 1 of every year and contains information for the previous calendar year.

New Jersey requires additional information from those manufacturers subject to Form R reporting. To facilitate this reporting, the NJDEP developed the Release and Pollution Prevention Report (DEQ-114) which is submitted to the Department with Form R. The additional information reported includes: maximum daily inventory, beginning and ending hazardous substances inventories for the reporting year, the quantity produced on site, the quantity brought on site, the quantity consumed on site, and the quantity shipped offsite (as, or in, a product), waste minimization information, and waste hauler information. The threshold for reporting is 10,000 pounds for all reportable substances beginning in reporting year 1993. Relevant data includes employer name, street, city, state, zip, SIC Code.

Actual Form Rs and DEQ 114s are available in hard copy. Both USEPA and some states have computerized databases of TRI data. NJDEP has DEQ 114 data computerized. The National Library of Medicine operates an on-line system dedicated to hazardous substances called TOXNET which carries TRI data. TRI data is also available through RTKNET, in Washington, DC and from USEPA on CD.

The advantage of this database is that it covers the entire United States, the large number of chemicals covered, its availability on electronic media, and the fact that it is updated annually. Its disadvantages is that it is based on self-reporting and covers relatively few employers because of high thresholds.

OSHA Integrated Management Information System (IMIS): a computerized database of OSHA inspection and industrial hygiene sampling results since June 1979. It is complete for states with federal OSHA enforcement; state plan data is incomplete. IMIS data can be obtained through Freedom of Information Act procedures. Relevant data includes employer name, street address, city, state, zip, SIC code, sampling results including chemical identity, job title, number similarly exposed, sample type and result, inspection date, and citation information. Substance codes are found in Appendix E of the OSHA IMIS Manual. State plans may have similar databases available.

The advantages of this database is that it contains actual air sampling data and job titles. Its disadvantages are that a very limited number of randomly selected employers is covered for any given year and that reporting to the database by OSHA industrial hygienists is believed to be incomplete.

Hazardous Waste Manifests: The New Jersey Department of Environmental Protection has a database of employers generating waste containing cadmium as well as a database of facilities which treat waste containing cadmium. Waste codes D006 -- Cadmium, and C157 -- Cadmium and Compounds, N.O.S. were used.

The advantages of this database is the large number of employers and chemicals covered, its availability on electronic media, and the fact that it is continuously updated. Its disadvantages is that it is based on self-reporting and that the pounds of waste listed may be deceptive since the weight of the entire waste is listed, not just the amount of cadmium or other specific component waste. Some listed treatment facilities will be located outside of New Jersey.

Thomas Register: A commercial publication targeted at purchasing agents which lists vendors for many products. It is available in many libraries in multi-volume hard copy or on-line through Dialog. The index lists 20 products beginning with the word "cadmium". Other relevant headings related to cadmium are "solder-silver", "pigments", and "colors-dry".

The advantages of this database is that it identifies employers not easily discovered through other avenues, is available on electronic media, is updated annually, and is available in many libraries. Its disadvantages is that the hard copy has no zip codes listed, that electronic searches may be expensive, and that searches require figuring out which headings to search under.

Cadmium Platers Directory: National directory, by state, of companies which do cadmium plating, published by the Cadmium Council, 12110 Sunset Hills Road, Suite 110, Reston, VA 22090, 703-709-1400.

The advantages of this database is that it comes from trade association information. The disadvantages is that it is available in hard-copy only and is updated irregularly.

NJ Employers Paying Unemployment Compensation Premiums: This NJ Dept. of Labor (NJDOL) database can be accessed by 4-digit Standard Industrial Classification (SIC) codes. SIC codes likely to be using cadmium were chosen from information given in the preamble to the OSHA cadmium standard. Codes 2816, inorganic pigments, and 2865, cyclic organic crudes and intermediates, and organic dyes and pigments, were chosen.

The advantage of this database is that it is a very up-to-date and complete listing of employers. The disadvantage is that four digit SIC Codes cover a wide range of industry types and are not very predictive for cadmium use.

Appendix 4

New Jersey State Department of Health
Occupational Health Service
Surveillance Program

INTERVIEW/CODING FOR CADEMP.DBF EVALUATION OF NEW JERSEY WORKPLACE WHICH USES CADMIUM

To begin, attach CADUSER printout or blank CADMIUM SURVEY on top of this form.

1. Codename of Company: _____ [CODENAME]
2. Do you still use cadmium?
- a ☐ Yes, no change or use increasing
- b ☐ Yes, use decreasing
- c ☐ Yes, plan to discontinue on ____/____/____
- d ☐ No, discontinued use on ____/____/____
3. How much cadmium or cadmium-containing material is used per year, in pounds? _____ [CADAMT]
(Also update in CADUSER)
- List each material separately; record total use above:
- _____
- _____
- _____
4. Which employees are exposed to cadmium and how? [CADEXPO]
- | Job Title | # of Empl. | Dept. | Bldg. | Tasks |
|-----------|------------|-------|-------|-------|
| _____ | _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ | _____ |
5. Have you begun to implement the provisions of the OSHA Cadmium Standard? 1 ☐ Yes 2 ☐ No [KNOWOSHA]
6. Which standard is applicable to your workplace? [OSHA]
- a ☐ 29 CFR 1910.1027 for General Industry
- b ☐ 29 CFR 1910.63 for Construction
- c ☐ 29 CFR 1915.1027 for Shipyards
- d ☐ 29 CFR 1928.1027 for Agriculture
7. Which exposure limit is applicable to your workplace? [PEL]
- a ☐ PEL
- b ☐ SECAL of 15
- c ☐ SECAL of 50

CODING FOR QUESTIONS 8, 10 THROUGH 14, AND 18 THROUGH 24:

1 - Not Applicable

3 - In Place, Inadequate

2 - Not in Place

4 - In Place, Adequate

If the control addressed in question is not applicable to the workplace or totally not in place, then directly code the question as 1 or 2. If the control is in place, then evaluate its adequacy by considering the criteria listed under the question. If you check one or more asterisked "No's," then code as 3-In Place, Inadequate.

NOTE: Effective dates are for Large businesses (L) and Small businesses (S), where: L = >19 employees.

8. Please describe your air monitoring [required 2/14/93 (L) and 4/14/93 (S)]. _____ [AIRMON]
- Initial complete: ☐ Yes ☐ No*
- Full shift personal: ☐ Yes ☐ No*
- Representative: ☐ Yes ☐ No*
- Repeat every 6 mo. if >AL: ☐ Yes ☐ No
- Ee notified in 15d: ☐ Yes ☐ No
- AIHA Lab Proficiency: ☐ Yes ☐ No

INTERVIEW/CODING FOR CADEMP.DBF

(Continued)

9. If air sampling has been performed, have employees been found to be exposed?

Over the AL? ☐ Yes ☐ No # _____

Over the PEL? ☐ Yes ☐ No # _____

10. Have you designated Regulated Areas for cadmium [required 3/14/93 (L) and 5/14/93 (S)]?

Based on exposures >PEL: ☐ Yes ☐ No*

Respirators required: ☐ Yes ☐ No*

Signs: ☐ Yes ☐ No*

Food, Tobacco, etc. Prohibited: ☐ Yes ☐ No*

[REGAREA]

11. Please describe Respiratory Protection to reduce cadmium exposures.

Proper selection: ☐ Yes ☐ No*

Available >PEL: ☐ Yes ☐ No*

Available >AL: ☐ Yes ☐ No

PAPR Available: ☐ Yes ☐ No

Fit-testing: ☐ Yes ☐ No*

Maintenance: ☐ Yes ☐ No

Written Plan: ☐ Yes ☐ No

[RESPRO]

Brand Name/Type

NIOSH Approval No.

Where Used

12. Please describe training for employees on health hazards and protective measures for cadmium [required 3/14/93 (L) and 5/15/93 (S)].

Hazard Communication Program: ☐ Yes ☐ No*

Annual: ☐ Yes ☐ No*

Content: Cd Health Effects: ☐ Yes ☐ No

Cd Exposure Sources: ☐ Yes ☐ No

Cd Exposure Controls: ☐ Yes ☐ No

[TRAIN]

13. Please describe Medical Surveillance for cadmium [required 3/14/93 (L) and 6/14/93 (S)].
(See pages 6-7 of Summary of Cd Standard for details.)

Selection of ee exp. >AL >30d: ☐ Yes ☐ No*

Selection of previously exp. >60 mo.: ☐ Yes ☐ No

Frequency: ☐ Yes ☐ No

Physician qualifications: ☐ Yes ☐ No

Lab proficiency Quebec: ☐ Yes ☐ No

Physician's written opinion: ☐ Yes ☐ No*

Multiple physician review: ☐ Yes ☐ No

Informing employee: ☐ Yes ☐ No

Content: ☐ Yes ☐ No

[MEDSURV]

INTERVIEW/CODING FOR CADEMP.DBF

(Continued)

-
14. Please describe Biological Monitoring for cadmium. _____ [BIOLMON]
- Cd in Urine: ☐ Yes ☐ No* [BLOOD]
- Cd in Blood: ☐ Yes ☐ No* [URINE]
- B-2-M in Urine ☐ Yes ☐ No [BETA]
- Frequency: _____ (Also update in CADUSER)
15. If biological monitoring has been performed, have elevated level been found?
- Cd in Urine ≥ 3 ug/g creatinine: ☐ Yes ☐ No # _____
- Cd in Blood ≥ 5 ug/LWB: ☐ Yes ☐ No # _____
- B-2-M in Urine ≥ 300 ug/g creatinine: ☐ Yes ☐ No # _____
16. What is the name, address and phone number of the laboratory which is used to analyze cadmium biological monitoring samples?
- Name: _____
- Address: _____
- City, State, Zip: _____
- Phone: _____
17. What is the name, address and phone number of the physician or clinic which you used for medical surveillance and biological monitoring? (Also record in CADDOCTOR)
- Name: _____
- Facility: _____
- Address: _____
- City, State, Zip: _____
- Phone: _____
18. Please describe medical removal of employees from cadmium exposure [required 3/14/93 (L) and (S)]. _____ [MEDREMOV]
- Removal decision made by physician: ☐ Yes ☐ No*
- Mandatory at CdU/CdB of 15: ☐ Yes ☐ No*
- Maintain wages: ☐ Yes ☐ No
- Maintain seniority: ☐ Yes ☐ No
- Maintain benefits: ☐ Yes ☐ No
- Return decision made by physician: ☐ Yes ☐ No*
19. Do you have a Written Compliance Plan as required by the OSHA Cadmium Standard [required 12/14/93 (L) and (S)]? _____ [COMPLAN]
- ☐ Yes ☐ No*
20. Do you have a written Emergency Plan as required by the OSHA Cadmium Standard (required 2/14/92)? _____ [EMGPLAN]
- ☐ Yes ☐ No*
21. Please describe change rooms, showers, lunchrooms and handwashing facilities for employees expose to cadmium [required 12/14/93 (L) and (S)]
- Handwashing Facilities: ☐ Yes ☐ No
- Change Room: ☐ Yes ☐ No*
- Separate Street and Work: ☐ Yes ☐ No*
- Showers: ☐ Yes ☐ No
- Shower End of Shift: ☐ Yes ☐ No
- Lunch Room: ☐ Yes ☐ No*
-

INTERVIEW/CODING FOR CADEMP.DBF

(Continued)

22. Please describe Engineering Controls to reduce cadmium exposures [required 12/14/94 (L) and (S)]. _____ [ENGCON]
Code as 4 - "In Place, Adequate" if exposures < PEL/SECAL.

Department Equipment Controls

23. Please describe Protective Work Clothing and Equipment to reduce cadmium exposures [required 12/14/92 (L) and (S)]. _____ [PPE]

Provided if PEL exceeded: ☐ Yes ☐ No*

Provided if eye/skin irritation: ☐ Yes ☐ No

Coveralls/Work Clothing: ☐ Yes ☐ No*

Type: _____

Provided clean once a week: ☐ Yes ☐ No

Who launders: _____

Gloves: ☐ Yes ☐ No

Type: _____

Eye Protection: ☐ Yes ☐ No

Type: _____

Work Shoes: ☐ Yes ☐ No

Taken home? ☐ Yes ☐ No

Other: _____

24. Do you use these special Housekeeping Procedures to reduce cadmium exposures [required 12/14/92 (L) and (S)]? _____ [HOUSE]

HEPA Vacuum: ☐ Yes ☐ No

Prohibit Use of Compressed Air: ☐ Yes ☐ No*

Prohibit Dry Sweeping: ☐ Yes ☐ No

Other: _____

25. FOR CONSTRUCTION INDUSTRY ONLY:
Do you have a designated "Competent Person" as required by the OSHA Cadmium Standard? _____ [COMPERS]

1 ☐ Yes 2 ☐ No*

Who: _____

26. Are employees represented by a labor union? _____ [UNION]
1 ☐ Yes 2 ☐ No (Also update in CADUSER)

27. Union Name: _____ (Also record in CADUNION)

Address: _____

City, State, Zip: _____

Appendix 4

INTERVIEW/CODING FOR CADEMP.DBF
(Continued)

28. Have you received a health inspection from OSHA in the past 5 years? 1 ☐ Yes 2 ☐ No [OSHINSP]

Health: ☐ Yes ☐ No Date: _____
 Cadmium: ☐ Yes ☐ No Date: _____
 Lead: ☐ Yes ☐ No Date: _____
 Other: ☐ Yes ☐ No
 Outcome: _____

29. Do you have other facilities in New Jersey that may use cadmium? ☐ Yes ☐ No

If yes, fill out name(s) on cadmium survey(s).

FOR ADMINISTRATIVE USE

30. Date of offsite evaluation: _____ [DATEOFF]

31. Individual performing offsite evaluation: _____ [INTEROF]

32. Status of offsite evaluation: _____ [STATOFF]

1 - Unable to Contact 4 - Incomplete per Protocol
 2 - Facility Closed 5 - Complete per Protocol
 3 - No Longer Using Cadmium

33. Date of CL05 mailing: _____ [MAILDATE]

34. Date of employer response to CL05: _____ [RESDATE]

35. Date of onsite evaluation: _____ [DATEON]

36. Individual performing onsite evaluation: _____ [INTERON]

37. Status of onsite evaluation: _____ [STATION]

1 - Unable to Contact 4 - Incomplete per Protocol
 2 - Facility Closed 5 - Complete per Protocol
 3 - No Longer Using Cadmium

38. Date of report: _____ [REPDATE]

39. Date of employer response to report: _____ [RRESDATE]

40. Taking into consideration the answer to questions 8, 9, 14 and 15, is it likely that this employer will begin to perform or expand biological monitoring for cadmium? [BEGIN]

- 1 ☐ Yes, will begin
- 2 ☐ Yes, will expand
- 3 ☐ Possibly, depending on air sampling results
- 4 ☐ No, exposures are not over the AL
- 5 ☐ No, already performing all required biomonitoring
- 6 ☐ No, use of cadmium discontinued

41. In which state is the lab used by the employer for analyzing biological monitoring? _____ [STATE]

42. Do you recommend referral to OSHA? 1 ☐ Yes 2 ☐ No [OSHAR]

Please explain: _____

Appendix 5

Cadmium Surveillance States Results from beginning of reporting through June 30, 1997

<i>State</i>	<i>date began</i>	<i>#blood</i>	<i>mean µg/L</i>	<i>#urine ()¹</i>	<i>mean µg/L ()¹</i>	<i>#individuals</i>	<i>#workplaces</i>
<i>CO²</i>	<i>1988</i>	<i>?</i>		<i>?</i>		<i>?</i>	<i>?</i>
<i>IA</i>	<i>1989</i>	<i>0</i>		<i>0</i>		<i>0</i>	<i>0</i>
<i>MD</i>	<i>2/88</i>	<i>0</i>		<i>4</i>	<i>29.0</i>	<i>4</i>	<i>all non-occ</i>
<i>MA³</i>	<i>2/92</i>	<i>72</i>	<i>7.5</i>	<i>76</i>	<i>9.05</i>	<i>63</i>	<i>7</i>
<i>NY</i>	<i>1982</i>	<i>66</i>	<i>19.4</i>	<i>325</i>	<i>12.0</i>	<i>276</i>	<i>89</i>
<i>NJ⁴</i>	<i>1985</i>	<i>218</i>	<i>7.9</i>	<i>116 (68)</i>	<i>19.9 (5.3)</i>	<i>320</i>	<i>19</i>

¹ *Urine reports in µg/gram creatinine*

² *No resources; reports archived without being counted. Reporting discontinued in 1997.*

³ *Not a SENSOR select condition*

⁴ *Reports through September 1997*

Appendix 6

Summary of Quebec Toxicology Center Cadmium Proficiency Testing 1998 First Semester Proficient Labs

Lab/State	Proficiency		
	Blood Cadmium	Urine Cadmium	B₂M
* American Medical, VA	YES	YES	YES
Blodgett, MI	YES	no	no
Diagnostic Products, CA	no	no	YES
Ellwood City Hospital, PA	no	YES	no
* Labcorp, NC	YES	YES	YES
Mayo Clinic, MN	YES	YES	no
* MEDTOX, MN	YES	YES	YES
Nat'l Medical, PA	YES	YES	no
Pacific Toxicology, CA	YES	YES	no
* Quest, CO	YES	YES	YES
* Quest, NJ	YES	YES	YES
* Smith Kline, CA	YES	YES	YES
Specialty Laboratories, CA	YES	YES	no

* proficient for all three analyses

December 1998
Summarized by NJDHSS